

## The Muridae of the Cocos-Keeling Islands

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A collection of house mice and rats from the Cocos-Keeling Islands made by Dr. C. A. Gibson-Hill of the Raffles Museum, Singapore has been received for identification in New York together with much valuable data on the history and geography of that group of islands. The Cocos-Keeling atoll with its approximately 25 islands is roughly circular with a wide opening on the northwest side. The mice, all from Pulo Selma, appear to be referable to *Mus musculus*. The individual islands from which rats of the genus *Rattus* were taken together with the numbers and categories of the rats from each are shown below:

Island		Rats with dark-colored underparts	Rats with clear whitish underparts
Tikus (Direction)	..	15	0
Bêras	..	0	1
Gangsa	..	0	9
Selma (Home)	..	0	19
Kechil	..	0	1
Ampang Bêsar	..	0	4
Kêmbang	..	0	3
Pandan	..	1	6
Atas	..	0	1
Bangka	..	0	1
Panjang	..	3	1

The 15 dark-bellied rats from Tikus are thought to represent the original rat population seen by Darwin (1836).

The presence of an allegedly late-introduced white-bellied race of roof rat, *Rattus rattus* on all the Cocos-Keeling Islands except Pulo Tikus where the dark-bellied, earlier-introduced race is endemic, has led me to reconsider the uses of the names *R. r. alexandrinus* and *R. r. frugivorus*. *Rattus alexandrinus* of Geoffroy St. Hilaire was described as having gray-white or yellowish ventral hairs with their bases dark gray, while *R. frugivorus* Rafinesque had the underside clear white. The problem of the relationship of the European races of *R. rattus* to one another has been examined repeatedly. Anderson (1902) pointed out that *R. rattus* both with gray-based belly hairs and with all-white belly hairs occurred in Egypt. Bate (1903) recorded only rats of *frugivorus* type in Cyprus. Bonhote

(1910), in his paper "On the varieties of *Mus rattus* in Egypt . . .", believed he could distinguish at least four phases of *R. rattus*. His multi-modal curves, based upon foot lengths, are unconvincing however since no account was taken of growth and age or sex. This question of the identities of the Mediterranean rats was again considered with care by Aharoni (1932). Following the views of the earlier writers, *Rattus r. alexandrinus* of Egypt (type locality, Alexandria) was stated to have the dark upper color shading gradually into the paler under color and the ventral pelage gray-based, in contrast to the sharp lateral line of color demarcation and all-white or yellowish white ventral hairs of *R. r. frugivorus* of Sicily, Italy, Syria and part of Palestine. Schwarz (1942) asserted that ventral color was darker in house-dwelling rats and paler in their open-living representatives.

Hybridization between the three common races of roof-rats, *rattus*, *alexandrinus*, and *frugivorus* in laboratories has been found apparently to follow Mendelian laws. De l'Isle (1865) determined that black *R. r. rattus* was partly dominant over white-bellied *R. r. alexandrinus*, no matter which way the cross was made. Morgan (1909) showed that *R. r. rattus*, which supposedly evolved under parasitic conditions, was dominant over *frugivorus*. Bonhote (1912) proved that *frugivorus* was dominant over *alexandrinus*, though a limited number of "fawn" offspring also appeared. The experimental work of those authors was reviewed by Barrett-Hamilton and Hinton (1916).

When the volume of human intercourse by water between Egypt and the north and east coasts of the Mediterranean Sea for the past 2000 years and the ease with which rats are ordinarily carried about on ships are considered, the likelihood of extensive interbreeding having taken place between the two races must be admitted. Nevertheless it seems possible that colonies of unmixed strains may still be found in isolated places.

The white-bellied rats of the Cocos-Keeling atoll conform to the characters given for *frugivorus* rather than for *alexandrinus*. They are reported to have appeared there following the wreck of an American ship, the "Robert Portner," in 1878 but they may have arrived even earlier (personal communication, Dr. C. A. Gibson-Hill). The places of call where rats might have entered this ship might conceivably be traced through her owners or the insurance brokers of that time but in any case it is unlikely that such ship-rats would represent an unmixed race when they arrived on the atoll. This supposition is partly borne out by the presence of the occasional dark-bellied rats noted from Pandan (one) and Panjang (three) Islands. The preponderance of white-bellied descendants from a probably mixed population of *frugivorus* and *alexandrinus* in the hold of the ship

seems to confirm the dominance of the *frugivorus* color pattern over the *alexandrinus* color pattern, (Bonhote, 1912). The skulls of the four dark-bellied *alexandrinus*-like individuals are similar to the skulls of the white-bellied ones. There is an albino from Pulo Panjang. All the foregoing differ in details of cranial structure indicated beyond, from the skulls of the Pulo Tikus rats.

Both the white-bellied and the dark-bellied rats from islands other than Tikus are to be regarded as heterozygous. With this reservation they can be treated respectively as *frugivorus* and *alexandrinus*.

The identity of the dark-bellied rats on Pulo Tikus is more problematical than that of the Cocos-Keeling *alexandrinus* and *frugivorus*. According to Guppy (1889, pp. 582 *et al*) the Cocos-Keeling atoll was discovered by Captain William Keeling when travelling from Bantam, Java, in 1609. It seems possible that Dutch explorers may have touched there at about the same time. There is no record of an actual landing (and of providing the opportunity for ships' rats to get ashore) until the arrival there in 1825 of Captain Le Cour on the brig *Mauritius* (from Mauritius?). Possible later carriers of the Tikus Island rat are:

1. The *Borneo* bringing Captain J. Clunies-Ross from Sumatra (1825) and later again from London, via the Cape, (February 1827) and finally from Batavia and the Sumatran ports (late in 1827).
2. The *Hippomenes* bringing Alexander Hare from South Africa, possibly via the Sumatran ports, in 1826.

When the Dutchman Van der Jagt visited the islands in 1829 Direction Island (= Pulo Tikus) was already swarming with rats. Darwin, who put in at the atoll in 1836 in the *Beagle* also refers to the Tikus Island colony; he wrote (1873, p. 456), "Some of the islets are inhabited by rats, which were brought in a ship from Mauritius, wrecked here .....". Dr. Gibson-Hill tells me that Clunies-Ross mentions two wrecks between 1825 and about 1840 in an unpublished letter which he wrote to Rear-Admiral Sir Bladen Capel outlining his early life. The first of these was an English vessel outward bound from London which went ashore on the south-west point of the atoll in 1826. The second struck in 1834; nothing is recorded of her except that the survivors were sent back to Mauritius. This may be the ship to which Darwin refers. If that is so he was wrong about the rats, as they were there in 1829. Possibly Le Cour's ship was also wrecked on the atoll, and Darwin confused the two. Dr. Gibson-Hill tells me that in his

autobiographical sketch Ross says that he landed on Pulo Tikus, which he calls Direction Island, in December 1825. Le Cour was not there then and Ross, who makes no mention of rats at this juncture, planted some fruits and shrubs which he had brought with him from Sumatra, intending to make use of them when he returned a year or so later. Van der Jagt in his report of the atoll in 1829 says that the Pulo Tikus rats were then so numerous that they ate anything planted on the island. Clunies-Ross might possibly have forgotten about the rats when he came to make mention of his 1825 visit fifteen years later, but as he was still on the atoll it seems unlikely. Alternatively Clunies-Ross might himself have introduced the rats unwittingly when he went ashore to plant his shrubs. The most likely solution on the evidence available at present seems to be that they came from Le Cour's ship and that within the space of less than a year they had not become sufficiently plentiful to attract attention. Unfortunately it has not been possible to obtain further details about Le Cour, or his earlier ports of call. The only point of interest is that Keating, who was on the atoll in 1829, says (in Holman, 4, 1846, p. 374) that some of Le Cour's crew had cut their names on the trunks of coconut palms in what seemed to him to be arabic characters. Possibly Le Cour had previously been trading on the east coast of Africa, or at least in the north-western part of the Indian Ocean.

I have compared the Tikus Island rats with our quite extensive collections from lands adjoining the Indian Ocean, without discovering continental rats which exactly match the island ones. Nor do European *R. r. alexandrinus* or *R. r. rattus* have skulls that agree. The gray-based ventral pelage of the Tikus race suggests certain of the African races—notably *R. r. kijabius* of East Africa—but again the skulls do not match.

We have no *Rattus* material from Mauritius. The few zoological lists of mammals from that island indicate merely the importation of European rats. But it is perfectly possible that a native race of *R. rattus*, which once existed (or still exists) on Mauritius, had made itself at home on Captain Le Cour's ship and was thus transported to the Cocos-Keeling Islands. If the Tikus Island rats were not derived from Mauritius they may have come from Sumatra or Java or elsewhere.

The external color characters of the Tikus Island rats are: dorsally brown, flecked with black. The individual hairs, of three types, comprise the usual scattered long black guard hairs; bristly, channeled over hairs, with brown tips and gray or whitish bases; and much finer subterete under hairs or wool hairs. The ventral pelage is composed of coarse overhairs and fine underhairs (but no guard hairs), their tips grayish buff, their bases very pale gray—giving the "gray-based" effect which



distinguishes this race and *alexandrinus* from *frugivorus*. The actual skin of the hands and feet is white; it is clothed with a mixture of very short gray and white hairs—those of the feet almost all white. The scale hairs of the tail above and below are fuscous. Dimensions are approximately those of normal *alexandrinus* or *frugivorus*.

The characters given above do not distinguish these rats from true *alexandrinus* or from various oriental races of *Rattus rattus* which also have gray-based ventral pelage. But on the other hand the characters of the skull (following) do distinguish them. I have been unable as yet to find identical forms of sutures in combination with the basi-cranial and pterygoid structures seen in Tikus Island rats in Africa, Indian or Malaysian races of *R. rattus*.

Skulls<sup>1</sup> of Tikus Island rats compared with those of *R. r. frugivorus* and *alexandrinus* of the remaining Keeling-Cocos Islands.

Structures discussed	Tikus Island Rats	Other Cocos-Keeling Islands Rats
Maxillo-premaxillary sutures at the place where they cease to be parallel to the nasal bones and descend each side of the rostrum	are sharply angled at the point of changed course.	are rounded at the point of changed course.
Posterior portions of the parieto-squamosal sutures	are placed relatively high and lie close to the posterior ends of the temporal ridges.	are placed relatively low, lying close to the posterior, ridge-like continuation of the zygomatic process of the squamosal.
The paired vacuities, dorsal from the pterygoids, opening into the brain cavity (internally, the anterior lacerate foramen plus the foramen rotundum; externally the interpterygoid foramen of Greene)	are relatively small and close together, and surpass but slightly the outer width of the combined pterygoids, measured at the palato-ptyergoid sutures.	are large and wide, and surpass considerably the outer width of the combined pterygoids.

<sup>1</sup>. The terminology of the cranial foramina, etc., of the rat skulls is that of Greene (1935, figs. 7-20).

<i>Structures discussed</i>	<i>Tikus Island Rats</i>	<i>Other Cocos-Keeling Islands Rats</i>
The foramen ovale	is relatively large, its alisphenoid opening smaller.	is relatively small, its alisphenoid opening larger.
The outer edges of the external pterygoid processes (ectopterygoids) posterior to the palato-ptyergoid sutures	are subparallel.	are posteriorly divergent to a marked degree.
The fronto-nasal sutures	are moderately to slightly dentate.	are very deeply dentate.

Because of the number of described species and races of *Rattus*, it is with reluctance that I propose yet another sub-specific name for the race of rats from Tikus Island, and Wood-Jones (1912) evidently felt similar reluctance. On the other hand many years more may pass before the real ancestry of that race can be determined. I am inclined to postulate Mauritius—and ancestral to that island, East Africa—as its country of origin. In the absence of immediate proof the Tikus Island race may be named.

*Rattus rattus keelingensis* n. subsp.

Type: A.M.N.H. No. 150162 (field No. 4041), adult ♀; collected by C. A. Gibson-Hill, December 27, 1940; Pulo Tikus (Direction Island), Cocos-Keeling Islands.

This race is distinguished from all others examined by the characters of the skull already indicated. The mammary formula in all adult females is  $2 - 3 = 10$ , the normal count for *Rattus rattus*.

Dimensions of the type: Skin (field measurements); total length, 381 mm.; tail, 205; hind foot (*s.u.*), 37.5; "ear", 21.5; skull (laboratory measurements): condylobasal length, 37.7; zygomatic width, 18.6; palatal length, 21.5; zygomatic plate, width, 4.10; length of bulla, 6.9; interorbital width, 5.4; mesopterygoid width, 2.4.

Besides the type, there are 14 paratypes.

A large part of the collection of *Rattus* and *Mus* has been returned to the Raffles Museum, Singapore, a representative series only having been retained at the American Museum of Natural History by kind permission of the authorities of the Raffles Museum.

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